FALL/WINTER 2017 | Volume 35, Nos. 3 & 4

FUTURES

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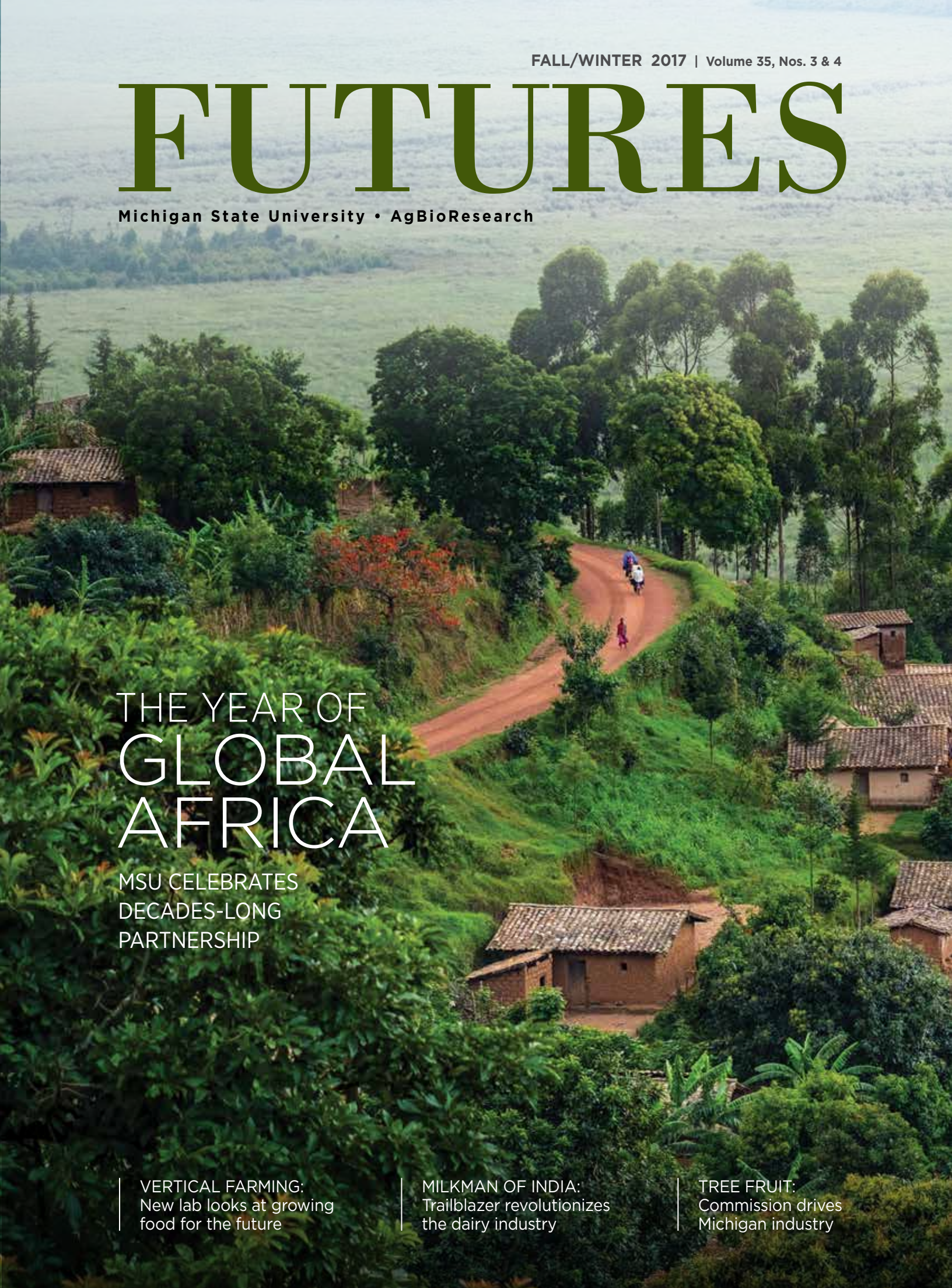


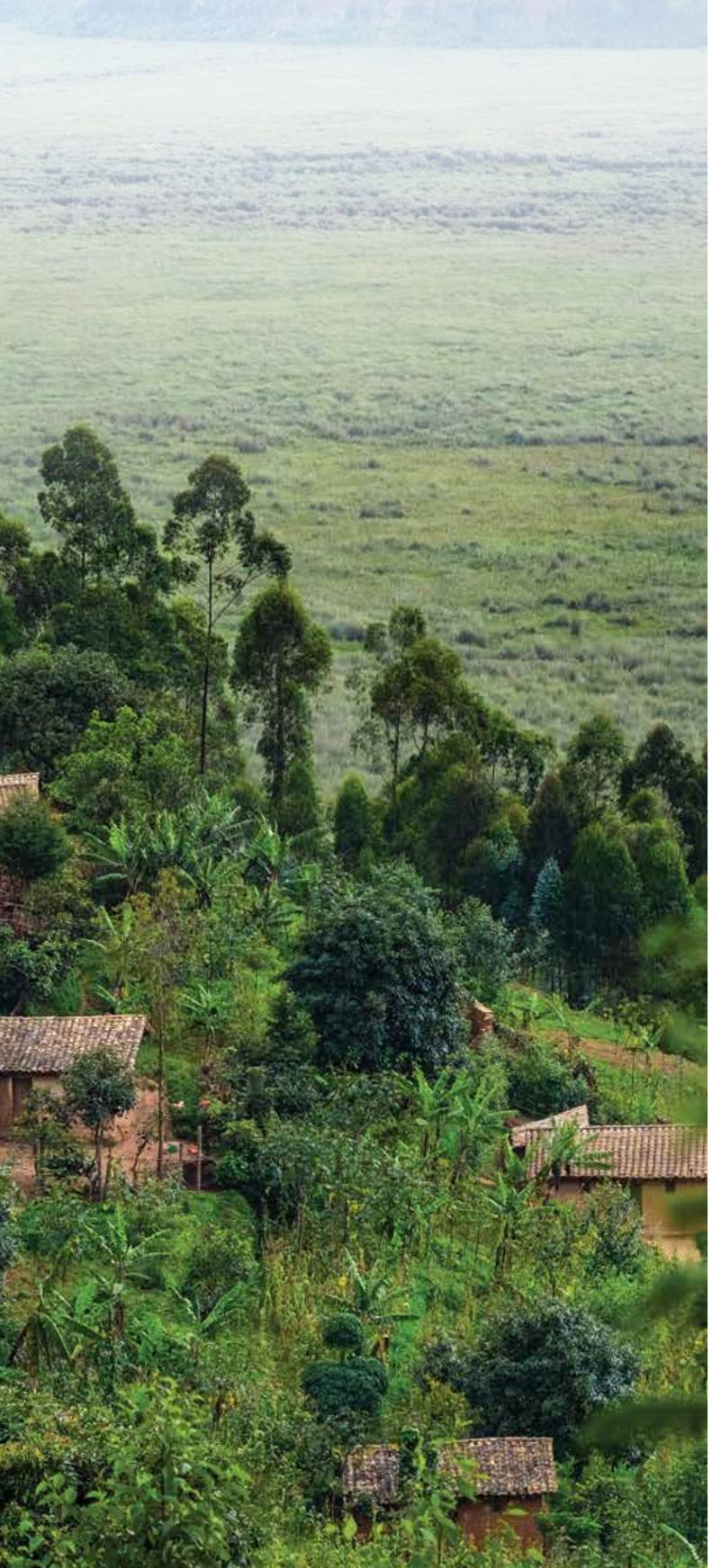
THE YEAR OF GLOBAL AFRICA

MSU CELEBRATES DECADES-LONG PARTNERSHIP

VERTICAL FARMING:
New lab looks at growing food for the future

MILKMAN OF INDIA:
Trailblazer revolutionizes the dairy industry

TREE FRUIT:
Commission drives Michigan industry



CONTRIBUTORS

Holly Whetstone
EDITOR

Cameron Rudolph
WRITER

James Dau
WRITER

Maddie Curley
WRITER

Katie Deska
WRITER

Anna Nichols
WRITER

Kurt Stepnitz
PHOTOGRAPHY, MSU COMMUNICATIONS AND BRAND STRATEGY

Patricia Adams
COPY EDITOR

Iain Bogle
CREATIVE DIRECTOR, BCP
EAST LANSING, MI

BRD Printing
PRINTER,
LANSING, MI

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Cover photo taken from a roadside overlook near Rushaki in northern Rwanda on a journey with MSU bean breeder Jim Kelly and his former grad student Gerardine Mukeshimana, now Minister of Agriculture and Animal Resources of Rwanda.

FUTURES

CONTENTS FOR FALL/WINTER 2017

MICHIGAN STATE UNIVERSITY | AgBioResearch

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MSU President John A. Hannah shakes hands with a Nigeria Project member. Dr. George M. Johnson, professor of education, is pictured on the right.

Photos courtesy of Michigan State University Archives & Historical Collections, East Lansing

EDITOR'S NOTE

Focus on Africa started with building land-grant university in Nigeria

Throughout the 2017-2018 academic year, Michigan State University (MSU) will celebrate its longstanding partnership – dating back more than 60 years – with Africa.

Traveling to Zambia in southern Africa in 2016, I witnessed firsthand how MSU is having an impact on farmers on the African continent by helping to improve food production and sustainable agriculture. I was amazed by how well MSU is not only recognized but also respected globally.

The first major milestone of this MSU-Africa union dates to 1960 when MSU received funding from the International Cooperation Agency (now the Agency for International Development) to start the University of Nigeria in Nsukka. The concept was the idea of Nnamdi Azikiwe, then the premier of the Eastern Region of Nigeria and close friend of then MSU President John Hannah.

It was agreed upon that MSU would help design and implement plans for a land-grant type institution to meet the needs of a developing country. The emphasis of the project, during its nine-year existence, ranged from developing curricula and staff to developing organizational structure and administrative processes for the university.

It was an integral part of a larger vision of Hannah's commitment to 16 African countries that had just won their independence. At the time, two-thirds of the world's population were living in poverty and Hannah wanted MSU students to have some idea of what that was like. This became the premise of the university's overseas programs and it changed the university from that point forward.

At MSU Archives, I unearthed the actual campus map of the University of Nigeria that was developed by the School of Urban Planning and Landscape Architecture within the College of Social Science at MSU. The university consisted of faculty in agriculture, business administration, education, engineering, science, social studies, arts, law and human medicine. An economic development institute was also established.

This endeavor, led by MSU Department of Agricultural, Food, and Resource Economics (AFRE) professors Carl Eicher, Glenn Johnson, Carl Liedholm and Warren Vincent, marked the beginning of MSU's commitment to giving others the knowledge and information to empower themselves. Unfortunately, war in the region where this project was located forced MSU faculty to evacuate and brought MSU's direct participation to an end.

In this issue, we get a personal perspective from AFRE department chair Titus Awokuse – who happens to be from Nigeria – about MSU's impact in Africa (see related article on page 4).

It's exciting to see that MSU President Lou Anna K. Simon is continuing the legacy of work in Africa. In fact, these efforts have resulted in a new partnership called the Alliance for African Partnership (see related article on page 10).

I am proud to be working for a university with such a longstanding commitment to helping people at home and around the world to address grand challenges such as producing food in sustainable ways to meet a growing global population. I hope you enjoy reading this issue that gives just a tiny glimpse of some of MSU's work in Africa – the world's second largest continent in terms of area and population.

Holly M. Whetstone

THE YEAR OF GLOBAL AFRICA

BUILDING ON A LEGACY OF PARTNERSHIP

BY CAMERON RUDOLPH, STAFF WRITER

For more than 160 years, Michigan State University (MSU) has been dedicated to a land-grant mission that emphasizes teaching, research and outreach. John A. Hannah, the 12th president of MSU who occupied the role from 1941 to 1969, was a steadfast believer in that model.

A 1923 graduate of the university, Hannah promptly netted a position with MSU Extension as a poultry specialist after receiving his degree. He served in that job for a decade until becoming the managing director of the National Poultry Breeders and Hatchery Committee.

Although not an employee of MSU, he remained in close contact with the university. After just one year, Hannah returned to accept the post of secretary of the State Board of Agriculture, the governing body of the university at that time. He remained in the position until assuming the MSU presidency.

Hannah's tenure as president is widely recognized as a period of tremendous growth for MSU. He headed initiatives to attract more students and faculty, implement innovative curriculum changes and extend the university's global reach.

A chief accomplishment of Hannah's was driven by his desire to spread the land-grant philosophy to areas where it could be most effective. Africa was a natural destination, encouraged by Hannah's close friendship with Nnamdi Azikiwe, who would later become the first president of Nigeria.

As premier of the Eastern Region of Nigeria, Azikiwe steered efforts to establish a new university in the country. In 1958, with assistance from various organizations, Nigerian leaders came together with scholars from the United Kingdom and the U.S., including Hannah.

The group drafted a white paper that outlined the challenges facing Nigeria and how a land-grant university could address them. An agreement was reached to open the University of Nigeria, Nsukka, in 1960 – the first land-grant university in Africa and a bastion of knowledge for the region.

Since then, MSU has further formalized its relationship with countries across the African continent. Research has expanded on the ground, and students from a variety of countries are attending MSU. In 2016, more than 330 MSU undergraduate and graduate students were from Africa, according to the MSU Office for International Students and Scholars.

Today, Hannah's legacy of cooperation with Africa carries on stronger than ever.

A GLOBAL LEADER IN INTERNATIONAL DEVELOPMENT

The founding of a new university is a colossal undertaking, and curriculum and program creation are an essential aspect of the startup process.

For the University of Nigeria, Nsukka, faculty members in the MSU Department of Agricultural, Food, and Resource Economics (AFRE) played a pivotal part. Among other contributions, AFRE professors Carl Eicher, Glenn Johnson, Carl Liedholm and Warren Vincent helped to establish an economic development institute at the university.

John A. Hannah, MSU President 1941-1969

From the beginning of the MSU-Africa partnership, AFRE has led the way. Currently, AFRE continues to hold the majority of the MSU research portfolio in Africa – and for good reason. The Center for World University Rankings named AFRE the fourth-best program in the world in 2017 for excellence in the agricultural and applied economics fields.

"Much of MSU's involvement in Africa is economic in nature, so it makes sense that AFRE is heavily featured," said Titus Awokuse, the AFRE chairperson. "The key to success in international development work is having a foundation of long-term relationships, and that's what we have in AFRE.

"At MSU, we don't just fly in and out. In addition to short-term visits by faculty and students, we also have people stationed long term in African countries who are doing research and constantly working with the people there to build local skills and capacity. People see us all the time, and that's important to establishing trust and credibility."

AFRE is awarded grants from a diverse swath of funding entities to engage with dozens of countries, but a significant number of projects funnel through the Feed the Future Innovation Lab for Food Security Policy (FSP). The Food Security Group at MSU is an integral partner in FSP and is composed of several AFRE faculty members.

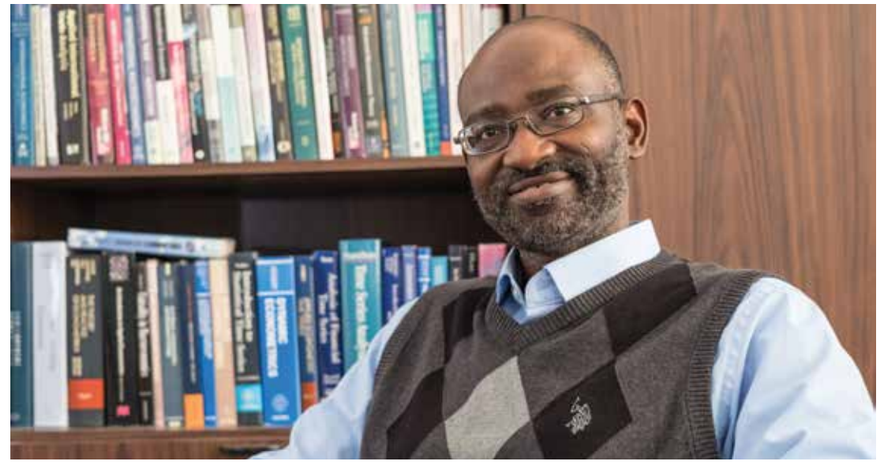
FSP is funded by the U.S. Agency for International Development (USAID) and is one of 24 labs supporting the U.S. Government's Feed the Future global hunger and food security initiative. FSP operates in eight countries in Africa – Burundi, Malawi, Mali, Nigeria, Rwanda, Senegal, Tanzania and Zambia – and two in Asia.

The mission of FSP is to promote inclusive agrifood system productivity growth, improved nutritional outcomes and enhanced livelihood resilience through improved policy environments.

Helping to draft new agricultural policy in developing countries is one of AFRE's major focuses. For example, AFRE assistant professor Lenis Saweda Liverpool-Tasie is the principal investigator on a $12.5 million FSP project that seeks to build internal capacity for Nigeria to perform evidence-based policy analysis.

Although Nigeria is the largest economy in Africa, with a GDP of $569 million, and has an estimated population of 187 million, it is among the poorest developing nations with a per capita income of $2,700.

Liverpool-Tasie and her colleagues are training a broad group of stakeholders, particularly faculty and students at Nigerian universities and research institutes. Training and informational workshops are also offered to Ministry of Agriculture staff. This will bolster the country's ability to participate in informed policy dialogue that ideally generates an outcome benefiting its citizens.



Titus Awokuse, who was born in Nigeria, is the chairperson of the Department of Agricultural, Food, and Resource Economics. The department currently leads 26 projects in 13 African countries that are funded at $68 million.

The project, which partners with the International Food Policy Research Institute, began in July 2015 and runs through June 2020.

Outside of FSP, AFRE receives funding from nongovernmental sources and foundations such as the Bill & Melinda Gates Foundation. Awokuse believes that these collaborations are vital to AFRE's future.

"Our goal is to build on our relationships with governmental organizations, USAID and others, but we must also be nimble and responsive to changing funding environments," Awokuse said. "That will mean diversifying our funding lines and strengthening bonds with all of our partners."

In his professional life as AFRE chairperson, Awokuse is tasked with examining the horizon to position the department for lasting success. But there is a personal angle to international development for him – especially in Africa. He doesn't speak of poverty and food insecurity in theoretical terms. He lived it.

"Part of my interest in these activities is because I'm an applied economist, but I also experienced the negative effects of poverty as a young man who grew up in Nigeria," Awokuse said. "My family and other people I knew were facing the same problems we're looking at today. I realize that the work of others helped to put me in the position that I am now, so this is a way for me to give back.

"In AFRE, we're helping to feed the world. We're helping to reduce poverty. These are things in which we should take great satisfaction."

BRINGING KNOWLEDGE HOME

In Ghana, a country on the West African coast that supplies 90 percent of its own food, more than half of the labor force is employed within agriculture. White yam is the nation's primary food security crop.

Only Nigeria produces a greater volume of the tubers. In total, more than 90 percent of all white yam around the world is from West Africa.

Cultivating the crop is a laborious endeavor, as most farmers utilize traditional agriculture methods. White yams develop from smaller seed yams that are planted on mounds. Stakes are placed beside the mounds in order for the yam vines to grow up and around them.

For many farmers, the exhausting effort is justified by the reward. White yam fetches a high return at local markets.

Prized for their sweet taste and rich nutrient content, white yams are often prepared by peeling, cooking and cutting into small pieces for inclusion in stews – alongside vegetables and meats. Pounding boiled yams with a mortar and pestle is another popular treatment, which creates a paste-like texture that is torn apart and eaten in soups with other ingredients.

Discovering ways to improve the growing process of white yams is especially important to Eric Owusu Danquah, a native Ghanaian and doctoral student in the MSU Department of Plant, Soil and Microbial Sciences.

"It's important for farmers in Africa to start looking at ways to scale up yam production to medium- and large-scale operations," Owusu Danquah said. "Most farming is currently very small in scale, and the technology being used is not the most efficient. Through my research, I hope to show farmers that adopting new strategies can improve their yields."

Owusu Danquah is principally interested in the impact of climate change on soil fertility and the ways it affects sustainable food production. He's always been cognizant of the importance of agriculture, a notion instilled by his father. Owusu Danquah is from Ofoase Kokoben in the Ashanti Region of Ghana. His father, a retired teacher, partakes in farming, so agriculture was never too far from the family's consciousness.

"As the eldest of my siblings, I always followed my father in the fields," Owusu Danquah said. "I gained a lot of experience with practical, hands-on agriculture. That got me interested in learning more about general agriculture, as well as other sciences."

In junior and senior high school, Owusu Danquah excelled. As his curiosity in science blossomed, the accolades followed. Honors included agriscience student of the year and overall student of the year.

Armed with his newfound knowledge, he entered his undergraduate program in natural resources management at Kwame Nkrumah University of Science and Technology in Ghana. He concentrated on the big picture.

"I've long understood that our natural resources on this planet are precious," Owusu Danquah said. "If we want to continue human development while also reducing inequality, we must treat our natural resources with respect. Giving people the tools to help themselves in a sustainable way has been my goal."

Owusu Danquah then earned a master's degree in agroforestry from the university, where he served as a teaching and research assistant, and spoke with mentors about potential career paths.

He opted to join the Council for Scientific and Industrial Research's (CSIR) Crop Research Institute in Ghana in 2011. Under the mentorship of CSIR Crop Research Institute director Stella Ama Ennin, Owusu Danquah has focused on agronomy – research that promotes policy development and examines the viability of new technology to improve smallholder farmers' livelihoods.

Eager to pursue a doctoral program while maintaining his position at CSIR, Owusu Danquah applied to the Borlaug Higher Education for Agricultural Research and Development (BHEARD) program in 2015. He was instructed to narrow his choice to three universities: two in the U.S. and one in Africa.

Meanwhile, Owusu Danquah began conversing with Cholani Weebadde, an assistant professor in the MSU Department of Plant, Soil and Microbial Sciences. A plant breeder, Weebadde was keen on engaging with researchers who worked with white yam. Speaking with Owusu Danquah, the ideas flowed freely.

"Talking with Eric was perfect timing because I was interested in white yam, particularly field work that we can't do in Michigan," Weebadde said. "He's done so much with white yam, and I wanted to tap into his experience. We worked with CSIR and BHEARD to come up with a Ph.D. program that was advantageous to all parties. Eric could further his research at MSU and take that knowledge home, and my program could gain access to a crop we've never studied before."

After choosing MSU, Owusu Danquah arrived on campus in August 2016. BHEARD students traditionally perform only their final year of research in their home country, but given that Owusu Danquah is working with white yam, his field trials needed to take place in Ghana. He required additional funding to support more trips to Africa.

"I WOULD RECOMMEND ANY STUDENT COME TO MSU, DEFINITELY AFRICAN STUDENTS."

– OWUSU DANQUAH

His MSU research team applied for and was awarded a grant from the Alliance for African Partnership, an MSU initiative that brings together partners inside and outside of Africa to look at new ways of addressing emerging challenges facing the continent.

Weebadde has urged Owusu Danquah to make as many connections as possible to build his network of colleagues. This has resulted in collaborations with MSU researchers such as David Kramer, a John A. Hannah Distinguished Professor of photosynthesis and bioenergetics.

Kramer's technology PhotosynQ, which involves a handheld device that takes measurements of a plant's photosynthetic efficiency and uploads the results to a publicly accessible database, has changed the way Owusu Danquah operates in the field.

PhotosynQ is just one of the technologies integrated into Owusu Danquah's research. His CSIR research group has brought mechanized ridging to yam farming, replacing the labor-intensive mound method.

Owusu Danquah is also introducing pigeon pea, a primarily East African crop, to white yam farmers in West Africa. Pigeon pea is a shrub that can be planted in alleys and between white yams. The idea is to use the pigeon pea's ability to fix atmospheric nitrogen, thus amending the soil for the more valuable white yam crop. If the soil is improved, farmers can avoid clearing more land for farming purposes.

On top of its benefits to the soil, pigeon pea may function as a natural stake, eliminating the expensive practice of employing artificial stakes.

Owusu Danquah emphasized that pigeon pea is a practical crop because it's drought tolerant and has edible grains.

"The yam-producing area is mainly from the northern part and the middle belt of the country," Owusu Danquah said. "Farmers in those areas don't have much pigeon pea knowledge, and we want to increase that in an effort to increase the likelihood of them using our technology."

By summer 2018, the research team should know whether the farmers' needs are being met and if they are likely to adopt recommendations.

Without the support of MSU, Owusu Danquah believes this research would not be possible. He is appreciative of the networking opportunities, and he can already see the positive effects of his work.

"I've had such a great environment to do research at MSU — building a network of colleagues," Owusu Danquah said. "I would recommend any student come to MSU, definitely African students. My advisers tell me that even when you finish your degree program, you never really leave MSU. You take those connections with you back to your country, and that helps throughout your career." ▯

A research team led by Eric Owusu Danquah (all four photos), a doctoral student in the MSU Department of Plant, Soil and Microbial Sciences, is exploring using pigeon pea as a way to amend the soil in white yam plantings. The pigeon pea may also act as a natural stake that allows the white yams to grow up and around them.

In addition to his role at MSU, Owusu Danquah is an agronomist with the Council for Scientific and Industrial Research's Crop Research Institute in Ghana. His director and mentor is Stella Ama Ennin (above).

Owusu Danquah is collaborating with several MSU scientists, including David Kramer, a John A. Hannah Distinguished Professor of photosynthesis and bioenergetics. Owusu Danquah is utilizing a technology developed by Kramer called PhotosynQ, which measures a plant's photosynthetic efficiency and uploads the results to a publicly accessible database.

Upper left:
Ruth Oniang'o and attendee

Upper right:
Panelists listen and respond to questions from the audience

Middle right:
Groups networking at the table

Below: right
Women collaborating together

Below: left
Jennifer Olson and Ruth Oniang'o speaking to the audience

Middle left:
Audience member listening to presenters

All photos from International Studies and Programs communications.

Reinvigorating MSU's connection with Africa

By Katie Deska, contributing writer

While 2017 marks the beginning of Year of Global Africa on campus, Michigan State University (MSU) has been working with partners on the African continent for many decades.

Before the African Studies Center was established at MSU in the 1960s, Nnamdi Azikiwe, who later became Nigeria's first president, reached out to MSU seeking a partnership to build a land-grant model university in Eastern Nigeria. In response, many MSU faculty and families were involved in creating and operating the first "land-grant" university on the continent. While the collaboration was put on hold during Nigeria's civil war and its aftermath, relations were officially restored in 1990. The depth of MSU's partnership with the University of Nigeria laid an important foundation for long and lasting cooperation between MSU and African universities, institutes and organizations.

In recent years, President Lou Anna K. Simon recently upped the ante by challenging MSU faculty to develop an innovative platform to engage campus researchers and continue building positive relationships with partners in Africa.

Consequently, MSU International Studies and Programs started a cross-continent brainstorming session that culminated in a three-day design workshop in May 2016. MSU faculty and African leaders across a variety of backgrounds convened to discuss what makes an effective partnership and what steps are involved to get there. From that vantage point, the Alliance for African Partnership (AAP) was initiated.

Launched in Tanzania in July 2017, AAP aims to increase institutional capacity and turn research into impact by strengthening partnerships among African institutions and continuing to build bridges to MSU.

"MSU has a reputation for building trusting relationships, for having a strong commitment to working with partners, and recognizing there's a mutual benefit," said Amy Jamison, AAP's associate director for institutional engagement.

"MSU has found research opportunities for our faculty. We've had fantastic grad students who become alumni, plus the international experience for our students, and the exchange with our colleagues around research and engagement—it's been a history of learning from one another. The majority of people at MSU take that approach, and AAP is trying to make that solidly institutionalized."

Over a dozen AAP grant projects, awarded in spring of 2017, will address six priority issues:

- agri-food systems
- water, energy and the environment
- youth empowerment
- education
- culture
- health and nutrition

Each project is spearheaded by researchers from decidedly diverse disciplines, with some projects including nontraditional development partners, such as rural community organizations and tech companies.

One $50,000 AAP grant will focus on the labor burden in agri-food systems that disproportionately falls on women. Using an approach to research and innovation that's responsive to a community's specific needs, environment and constraints, the team is working to solve challenges that put extra pressure on women in East Africa's rural communities.

MSU researchers Jennifer Olson and Susan Wyche from the Department of Media and Information, Erik Goodman and Tim Schmidt from the BEACON Center for the Study of Evolution in Action, and Hannah Robar from the Center for Language Teaching Advancement, partnered with Ruth Oniang'o from the Rural Outreach Africa, and Erik Tarkleson, chief engineer for Tanzania-based Enda Tech, to develop locally-based tech innovations that can help overcome added stressors for women in agriculture.

AAP is intended to be more than just another network.

"Our intention is to think about partnership itself in new ways," said Jamie Monson, AAP co-director and African Studies Center director. "MSU has always had a good ethic in partnering with Africa, but we were keen to imagine what a new landscape for partnership might look like. How can we have partnerships that are equitable, transparent, and that enable and empower Africa's institutions to move towards working to solve their challenges with us in a role as allies? We couldn't just sit here at MSU and say, 'Ok, here's how we're going to design the partnership of the future.' We realized we couldn't go forward until we invited our partners to join together with us in our innovation process. So, we had the convening in May of 2016."

One unexpected partnership already afoot involves Faraja Nyalandu, a young Tanzanian entrepreneur who developed Shule Direct -- an app that provides school children with online access to books and coursework. Monson was introduced to Nyalandu through the Segal Family Foundation and later invited her to MSU. It was through this that the young woman was introduced to leaders with MSU's Tanzania Partnership Program, which focuses on educational access, among other key issues.

"That's the kind of partnership, networking, that's not really going to be on the radar, but its reverberation," said Monson. "When you build friendships and relationships, then people begin to meet each other and you can facilitate people coming together."

BY MADDIE CURLEY, CONTRIBUTING WRITER

Helping dairy cows transition & decreasing reliance on antibiotics

ABOUT 70 PERCENT OF THE DISEASES A DAIRY COW MAY GET IN A LIFETIME WILL OCCUR DURING THE FIRST MONTH AFTER GIVING BIRTH, OFTEN REFERRED TO AS THE TRANSITION PERIOD. DURING THIS TIME, IMMUNE DYSFUNCTION CAN FREQUENTLY OCCUR RESULTING IN A RANGE OF INFLAMMATORY-BASED DISEASES THAT AFFECT THE UDDER, HOOVES AND UTERUS.

More than one-third of all dairy cows in the U.S. – more than 3 million cows – succumb to these inflammatory-based diseases every year:

- Mastitis, an inflammation of the mammary gland and udder tissue, is often caused by a bacterial infection and can result in permanent damage to the udder.
- Laminitis, an inflammation of the hoof wall, can cause lameness, affecting a cow's ability to walk properly.
- Metritis is inflammation of the uterus, which can be detrimental to fertility.

Struggling with the high costs of treating sick cows and decreased milk production, dairy farmers are desperate for a solution.

Lorraine M. Sordillo, Meadow Brook Chair in Farm Animal Health and Well-Being in the College of Veterinary Medicine at Michigan State University, is tackling these transition cow diseases with a primary focus on the most common disease – mastitis. By examining the effects of metabolic stress on the health of transition cows and identifying disease-preventative solutions, Sordillo's work on mastitis can also be applied to laminitis and metritis.

This award-winning research program was recognized by the American Dairy Science Association (ADSA) with the 2017 Zoetis Physiology Award for outstanding dairy physiology research. Eligibility for the Zoetis Physiology Award requires research in any area of animal physiology relating to the dairy animal published in refereed journals in the five years immediately preceding the year of recognition.

PASSING THE TORCH

After more than 30 years in the industry, Lorraine Sordillo believes she has a responsibility to teach the next generation of dairy researchers. She has served as the primary adviser to more than 40 graduate students and postdoctoral research associates.

"I take comfort in knowing we're training the next generation of big thinkers who will serve the industry after we're gone," she said. "Our research team has a passion for improving the health and well-being of dairy cattle, and our goal is to pass that enthusiasm on to the students."

For Sordillo, the best part of her job is watching graduate students and postdoctoral associates grow and progress in their research and career goals.

"Failure is a big part of the job," Sordillo explained. "You don't always get it right the first time. Nothing is more rewarding than watching students and trainees learn from their struggles and leave the program with more confidence than they started with."

Andre Contreras, faculty in MSU Large Animal and Clinical Sciences, with Lorraine Sordillo

"Although they honor me [with this award], research is a team effort and a reflection of the hard work by our graduate students and research assistants."

– Lorraine M. Sordillo

Recipients must also be a member of ADSA for at least the last five successive years.

"It's a special thing to be recognized by your peers," Sordillo said regarding the award. "Although they honor me [with this award], research is a team effort and a reflection of the hard work by our graduate students and research assistants."

FEEDING A GROWING WORLD

New industry solutions discovered by Sordillo and her team include management techniques for reducing the occurrence of mastitis. This disease, which can eliminate a cow's ability to produce milk, causes an estimated $2 billion in losses for U.S. dairy producers every year and is increasingly becoming a global problem.

"This issue has long plagued the industry and reaches beyond our borders," said Sordillo. "Finding new ways to keep cows healthy while reducing production losses is a win-win. Mastitis has significantly reduced global milk production efficiency, and we're working to find better solutions to feed a growing world population."

FIGHTING MASTITIS THROUGH IMPROVED NUTRITION

Sordillo said her program aims to attack mastitis by identifying the links between altered nutrient metabolism, oxidative stress and inflammation, and the effects they have on the development of mastitis. This science is working to improve dairy cattle health and provide farmers with preventative strategies that reduce the use of antibiotics and thus, reduce the chances of developing antimicrobial resistance.

By exploring the relationship between changes in nutrient requirements and immunity in terms of a cow's disease susceptibility during calving, the team can identify nutritional strategies to help optimize sufficient immune responses to prevent disease.

"Nutrition and immunity are integrally linked and nutritional management prior to calving can determine the health and well-being of cows throughout the entire lactation period," Sordillo explained.

Working with several commercial dairy herds in Michigan, Sordillo is studying changes in metabolic stress and immune dysfunction during the lactation cycle to better predict when certain cows are at a greater risk of becoming sick.

In 2016, Michigan was ranked one of the top five milk-producing states in the nation – with the equivalent of 1.3 billion gallons of milk produced last year.

"Nutritional interventions that enhance the cow's immune system during the transition period improve production efficiencies and reduce the need for antimicrobials," said Sordillo. "Increasing efficiencies is crucial to the Michigan dairy industry and worldwide for keeping cows healthy and remaining profitable."

The ability to identify at-risk cows allows producers to proactively prevent illness. A better understanding of optimizing dairy cattle immunity and tools that can help producers identify those at risk could lead to improved disease-prevention strategies. These strategies will reduce the reliance on antibiotic use for disease control and optimize production efficiency in the U.S. dairy industry. ▯

Growing Food in the Future:

New MSU laboratory provides opportunity to explore vertical farming

BY HOLLY WHETSTONE, EDITOR

IT'S NEARLY IMPOSSIBLE TO WALK BY THE NEW CONTROLLED-ENVIRONMENT LIGHTING LABORATORY (CELL) IN THE PLANT AND SOIL SCIENCES BUILDING ON THE CAMPUS OF MICHIGAN STATE UNIVERSITY (MSU) WITHOUT PEEKING INSIDE. FLASHY STREAMS OF COLORFUL LIGHT BEAM INTO THE HALLWAY BECKONING PASSERSBY TO LOOK IN THROUGH THE WINDOWS ON WHAT COULD ARGUABLY BE THE MOST HEALTHY-LOOKING LETTUCE AND KALE AROUND.

Photos by Derrick Turner, MSU Communications and Brand Strategy

The unique space is the first of its kind allowing MSU faculty, staff and students an opportunity to study vertical farming – the practice of growing food and other specialty crops in vertically stacked layers or vertically inclined surfaces as well as integrating crop production in other structures.

Erik Runkle, professor in the MSU Department of Horticulture, developed CELL to:

- Conduct research on controlled-environment production of high-value specialty food crops, such as leafy greens and herbs, along with ornamental plants, such as seedlings and cuttings.
- Demonstrate indoor growing systems to inform growers and capture the interest of students and the public.
- Provide teaching applications for undergraduates enrolled in relevant horticulture production courses.

The laboratory consists of two independently controlled and refrigerated growth rooms filled with stacked shelves of plants grown hydroponically – meaning recirculated water, no soil. State-of-the-art light-emitting diodes (LEDs) developed in collaboration with OSRAM and OSRAM Opto Semiconductors allow for alterations of light quality and intensity.

Runkle said research conducted in CELL focuses on lighting to produce crops with desired traits such as leaf size, texture, thickness and color, as well as taste and nutritional content. Since vertical farming is a relatively new way of growing food crops and other plants indoors, Runkle said the setup of the lab where those in the hallway can look in on the plants has helped spark interest in the subject matter.

"Vertical farming is potentially suitable for crops that are produced quickly, have high value, are perishable, are small and have a large harvestable index," said Runkle. "This includes leafy greens (such as lettuce, arugula and kale) and herbs (such as basil and mint), as well as ornamental transplants for the floriculture industry and field transplants for the vegetable industry."

"CITIES LIKE DETROIT HAVE MANY FOOD DESERTS. I THINK THIS MIGHT BE A WAY TO ADDRESS SOME FOOD CRISES".

"Indoor farming is not appropriate for agronomic crops, which are comparatively large, have long production cycles, have high light demands, and only a small part of the plant is typically harvested."

CELL is a place where Qingwu (William) Meng, one of Runkle's doctoral students, spends much time. A strong advocate for science communication, Meng said he believes that this lab layout – easily viewed and accessible – can help with the public's acceptance of new technologies and scientific advancements, such as vertical farming.

"Vertical farming has only recently started to scale up," he said. "It's a small fraction of agriculture in the U.S. and globally. As a result, it hasn't contributed a lot to the whole economy these days. But, we'll have to feed 2 billion more people in the next 30 years. We really need to think about alternative ways of growing food and providing food to people in need."

Vertical farming is a way to supplement food production, especially in large cities where land is limited and where some are willing to pay more for fresh, local produce all year round. The concept is not that new; it's been around for a few decades in Japan, where indoor farms are referred to as "plant factories." However, the industry is only beginning to emerge in the U.S., where people increasingly want locally sourced, healthy and fresh food.

"It's difficult to get fresh lettuce in Michigan during the winter," Meng said. "We're reliant on lettuce produced in California and Arizona so by the time the plant gets to us, it may have already spent several days in trucks. It's lost some of its visual appeal and nutritional value. It also doesn't taste as good anymore."

SHINING THE LIGHT ON RESEARCH

Runkle and Meng are researching the impact different LED colors and intensities have on plant growth, leaf shape and color, and nutritional benefits. Eventually, they will look at ways in which lighting can improve flavor.

"We know that by modulating the light spectrum we can influence plant growth and development," Meng said. "We can alter light quality and quantity to regulate both photosynthesis and secondary metabolism, the process where nutritional and flavor compounds are produced. These are some added benefits of growing crops indoors under LED lighting."

Specifically, the duo is looking at ways to change plant shape and promote growth by adding green and far-red light (which we can't see, but influences plants) to traditional blue and red light. Around four weeks after seed germination, plants will be measured for several growth attributes including yields and leaf size.

Both Runkle and Meng realize the uphill battle vertical farming faces. They say operating a vertical farming system is expensive. Although the LED lights are more efficient than traditional lights – such as fluorescents – they still consume considerable electricity and emit heat that needs to be pulled out of the room. As the largest operating cost, electricity for the lights and cooling system is generally the most intimidating to potential entrepreneurs. Capital costs for the lights is also quite high.

MSU doctoral student Qingwu (William) Meng works in the new Controlled-Environment Lighting Laboratory.

Although some have worked out viable business plans, many who make a go of it struggle despite advantages such as little to no pests or diseases, water conservation (some companies estimate over 90 percent less water is used compared to traditional field farming), the ability to produce locally all year round and much lower transportation costs to the market.

"If you can find a niche market and design your operation and business model properly, vertical farming can work," said Meng. "But it's also a risky business, and that's why some of the companies in this market – even some big ones – have gone bankrupt."

Runkle and Meng say their goal is to help steer research to help optimize the vertical farming system and make it more readily viable by producing higher quality crops with lower energy costs. They've personally witnessed an increased growth rate in vertical farming and believe that using abandoned buildings, where trays of plants can be stacked 10 to 15 layers deep, could prove to be extremely impactful.

"If you have some vacant warehouses or buildings, conceptually you can convert them to productive plant factories to feed people living there," said Meng. "Cities like Detroit have many food deserts. I think this might be a way to address some food crises."

"The truth is, through CELL, we're delivering the same photons from LEDs as you can get from sunlight," Meng said. "A lot of people will call these LEDs 'artificial lighting,' which is a term I tend to avoid. The photons, no matter whether from the LEDs or from sunlight, are the same physical matter. Unlike sunlight, the photos from LED aren't free, but with LEDs, we can tweak the light spectrum to get better control of plant traits, which may justify the added costs."

TRANSITIONING FROM ENGINEERING INTO VERTICAL FARMING

Meng wasn't always so interested in vertical farming. He spent his first 18 years of life in Lanzhou, in northwestern China, before moving to Beijing where he earned an undergraduate degree in agricultural engineering. He came to the U.S. five years ago to pursue his graduate degrees.

It was a thesis project during his last year of undergraduate studies that ignited his interest in plant biology. He evaluated different lighting fixtures to benefit plant growth. Afterwards, he came to MSU to study how different colors of light controlled flowering of greenhouse ornamental crops.

"Then I got more and more interested in vertical farming, still revolving around the theme of LED lighting in agriculture," he said. "I was thinking more about the food crises we are having or will be having in the future and how to solve those food production problems. As I was conducting horticultural lighting research, I realized how much potential it could have for future farming."

In addition to support from OSRAM, CELL is funded by MSU AgBioResearch, Project GREEEN (Generating Research and Extension to meet Economic and Environmental Needs) and the American Floral Endowment.

Aquatic Invaders

Defending the Great Lakes from invasive species

An invasive species is an organism that is not native to an ecosystem and whose presence causes harm to the surrounding environment. Issues arise because invasive species have no natural predators to cull their numbers, nor do the species on which they prey possess any natural defenses against them. In the Great Lakes region, the Environmental Protection Agency has identified at least 25 invasive fish species.

BY JAMES DAU, STAFF WRITER

Invasive species are notoriously difficult to eradicate and often continue to wreak havoc upon the ecosystem long after their arrival. Michigan State University (MSU) scientists in the Department of Fisheries and Wildlife are working to develop and implement plans to reduce the number of invasive species to manageable levels and safeguard a natural system critical to the ecology and the economy of the entire region.

MSU associate professor Michael Wagner has spent the last 15 years studying sea lampreys in Michigan. Now, his team is working to keep them out of the state's river ecosystems.

BUILDING A BETTER DAM

There are thousands of dams in the Great Lakes basin, serving a multitude of purposes. Some provide drinking water or generate electricity; others are used to control the spread of invasive species. Particularly one of the most notorious of the invasive species is the sea lamprey.

Native to the coastal waters of the Atlantic Ocean and found throughout much of southwestern Europe, the sea lamprey is relatively unique among fish. Lacking jaws, paired fins and bone structure, this eel-like creature has remained relatively unchanged for over 340 million years, including at least four major extinction events.

Perhaps the most notable characteristic is its large, disk-shaped mouth lined with rows of sharp teeth in concentric circles. The sea lamprey uses its mouth like a suction cup to attach to prey fish, feeding on their blood and other bodily fluids. Over the course of their adult lives (between 12 and 18 months), one sea lamprey can kill up to 40 pounds of fish.

The sea lamprey was first discovered in the Great Lakes in 1835 and decimated indigenous fish populations throughout the 1930s and 1940s. Since then, new methods of control have reduced their impact and allowed fish populations to improve. Wagner's research represents the next step in that process.

The sea lamprey was first sighted in the Great Lakes in 1835, in Lake Ontario, where it likely traveled upon the opening of the Erie Canal. In the early 20th century, it spread to Lake Erie through newly improved canals, and soon after, into the remaining three Great Lakes. There it decimated native fish populations, and opened opportunities for other invasive fish such as the alewife to do the same thing – threatening to collapse the entire commercial fishery.

Like salmon, the sea lamprey must migrate up rivers and streams to spawn. Unlike salmon, it is not driven to return to the exact stream of its birth. Once it reaches suitable spawning grounds, a single female can lay up to 100,000 eggs.

In Michigan, many dams are maintained to deny sea lampreys access to spawning grounds. Coupling the dams with applying a pesticide specifically tailored for sea lamprey to the rivers, management agencies developed an effective practice that reduced their population by over 90 percent from historic peaks.

This practice came at a cost. The rivers were artificially blocked from the Great Lakes, disrupting the free and open connection within the ecosystem. In addition, maintaining the dams and treating the rivers carries a financial cost of approximately $20 million each year.

Michael Wagner, MSU AgBioResearch fish ecologist, has been studying sea lamprey in the Great Lakes for over 13 years. Through a grant from the Great Lakes Fishery Commission (GLFC), he has turned his attention toward developing a new style of dam that prevents sea lamprey from traveling to their spawning grounds while preserving the connection between the rivers and lakes.

"One of the great challenges facing ecosystem management in the Great Lakes is there are competing interests in restoration," Wagner, associate professor in the MSU Department of Fisheries and Wildlife, said. "One is reconnecting rivers with the lakes, and the other is the necessity of blocking lamprey access to a number of rivers, in order to keep their population manageable."

Providing fish with ways to circumvent dams has been an ongoing challenge in North American fisheries for 100 years, and in Europe for four times as long. The most common passage is a structure called a fish ladder, a series of stepped pools that fish such as salmon and trout can jump up to get past the dam. Unfortunately, these are an imperfect barrier for sea lamprey. In addition, other fish cannot jump or swim hard enough to pass over the barrier.

Wagner said he realized his team would have to pioneer an entirely new, selective fish passage that could act as a biological filter, keeping out sea lamprey while allowing other species free access. It presented a significant challenge, but one the team was prepared to address.

"Lamprey have two things going for us that allow us to separate them from other fish," Wagner said, "First, they swim radically differently, by full-body undulation. That means they can do something no other fish can, which is climb a studded ramp. That gives us a physical way to sort them from the rest. Second, they have a very strong anti-predator response that's driven by only one sense – smell."

Many fish produce an alarm cue, an odor released when their skin is ruptured, warning others of their species downstream of the attack. In most fish, sensing that odor causes them to slow their movement, reduce the amount of time they spend foraging and look for threats. Sea lamprey, which migrate primarily at night in dark conditions, use smell, which limits their anti-predator options. Instead of slowing down upon detecting the alarm odor, sea lamprey bolt away from it.

Wagner and his team constructed a trial fish passage on the Ocqueoc River in the northeast Lower Peninsula. They divided the fish passage into two channels – one side that allowed fish free movement upstream and the other ending at a studded ramp only sea lamprey could climb. The team released a plume of sea lamprey alarm odor in front of the open side of the passage, hypothesizing that it would drive the lamprey toward the ramp. It did and the rest of the fish continued through the passage unabated.

"We're trying to do two things no one has ever done before," Wagner said. "One is creating a fishway that allows fish to travel through at high numbers and diversity, and the other is to create one that excludes a particular undesirable species. It's the kind of high-risk, high-reward project I love, and we're seeing good results so far."

To determine if the device has wider applications for sea lamprey management, it has to be tested at a larger scale. Wagner has joined a team led by the GLFC to design a large selective fish passage facility at the Boardman River's Union Street Dam site in Traverse City. Through a nearly $12 million grant from the Great Lakes Restoration Initiative, the facility will be used to test Wagner's unique approach to blocking invaders while allowing desirable species to pass.

"Controlling invasive species like sea lamprey is a really hard game to win," Wagner said. "It's all or nothing. We're trying to find a means by which we can help reconnect our lakes and rivers without harming our ability to protect them from sea lamprey."

BRINGING THE BEST IDEAS TO THE TABLE

Sea lamprey are far from the only invasive species threatening the Great Lakes. Asian carp, a group of four invasive carp species causing ecological problems in the United States, has been another high-profile invader for decades. While most came to North America as stowaways in ship ballasts, the grass carp was intentionally brought from eastern Asia to control weeds in aquaculture facilities.

The grass carp is now found in 45 states. They were first discovered to be reproducing in Lake Ontario in 2013, and have since been caught in lakes Erie and Michigan.

Seth Herbst, an aquatic invasive species coordinator with the Michigan Department of Natural Resources (MDNR), has been monitoring grass carp in the lakes since they were discovered.

"With grass carp, we're not seeing the same population explosion we've seen in other Asian carp species, but it's still higher than it's ever been." Herbst said. "By feeding on plants, they directly modify the habitats of commercially and ecologically critical native fish species."

Grass carp can consume up to 90 pounds of plant matter daily, but they only digest about half of what they eat. The remainder is expelled back into the water, where it fuels toxic algal blooms.

Lake Erie is the epicenter for grass carp in the Great Lakes, a complex

People have lived and thrived on the abundant natural resources of the Great Lakes region since the last glaciers receded more than 3,000 years ago. Covering more than 94,250 square miles across eight states and two provinces, the lakes, and the larger watershed surrounding them contain nearly 21 percent of the surface freshwater on Earth.

Upon this vast aquatic repository, a rich, layered ecosystem has flourished and upon which millions in the agriculture, fishing, shipping and tourism industries depend. The National Oceanic and Atmospheric Administration's (NOAA) Great Lakes Environmental Research Laboratory estimates that commercial and sport fishing generate approximately $5 billion per year for the region, while over 200 million tons of cargo are shipped across Great Lakes waters annually.

According to NOAA, tourism generates an additional $16 billion annually, as people from around the nation and the world travel to the region for its breathtaking scenery and innumerable opportunities for outdoor recreation, including approximately 37 million anglers, hunters and bird-watchers.

The same human activity that depends on these ecosystems has also introduced disruptive forces, such as invasive species, that threaten them. Whether they found passage aboard a ship, were introduced for sport or by some other means, over 180 aquatic species have found their way into the watershed, according to the Great Lakes Fishery Commission (GLFC). While the majority fail to establish significant populations, some invasive species have found much greater success.

environment in which to study and manage any fish population.

"It's one of the largest bodies of water in the world, not exactly a confined space where you can easily find and remove the fish you're looking for," Herbst said. "It involves multiple states and provinces, who all need to make sure their efforts are coordinated."

To address these challenges, Herbst reached out to Kelly Robinson and Michael Jones, MSU AgBioResearch scientists with the Quantitative Fisheries Center, to come up with a plan.

Starting in December 2016, Robinson led a series of structured decision-making workshops over the course of nine months. She guided participants as they broke down the issue and brainstormed ways to tackle it.

"Structured decision-making is a five-step process that helps you divide a decision into discrete parts, work on each of them separately and then put it back together into a cohesive whole," Robinson, assistant professor in the MSU Department of Fisheries and Wildlife, explained. "It's a good framework for working through complex issues in a formal manner."

Structured decision-making begins with identifying the problem, a step that may seem obvious, but when a diverse group of stakeholders comes together, they often have different ideas regarding the specific nature of the problem.

The group then lays out the values, such as economic or social concerns, that are most relevant to the issue. In the third step, they determine objectives, in this case reducing the grass carp population, and in the fourth, they consider how different management techniques might impact those objectives. Finally, the group reevaluates and reprioritizes their objectives in light of the impacts management techniques may have on them.

What has begun to emerge is an adaptive management plan that would provide fisheries managers with a multitude of tools to control grass carp. Examples include modifying the flow of rivers to make them less suitable for spawning and conducting the targeted removal of fish using methods such as bioelectrode fishing.

Concurrent with the workshops, Robinson's post-doctoral researcher Mark DuFour has worked to create a grass carp population model in Lake Erie capable of simulating both the size and characteristics of the population, as well as the impacts of the various management practices.

"The Great Lakes are such an important resource for so many people. Anything that could damage them is something we all need to take seriously," Robinson said. "The plans emerging from these workshops could determine the course of grass carp management in the lakes into the future, and protect the industries and natural resources that depend on them."

BIRDS ON THE BRAIN

Not every Great Lakes invasive species is a fish. In the late 19th century, mute swans were introduced to the United States from their native ranges in Europe. They were brought to adorn city parks and the large estates of the wealthy with their great size and striking white plumage. Over time, many of these birds left their original confines, whether by escape or intentional release, and began to spread across the nation.

In 1919, the first pair of feral mute swans arrived in Charlevoix County in Michigan's northern Lower Peninsula, marking the beginning of a population that grew by 15 to 22 percent annually until it comprised 2,000 birds in 1990. That same year, a new population established itself in the southwest corner of the state. Taken together, the MDNR estimates the mute swan population peaked at around 17,500 individuals in 2013, having grown at a rate of 9 to 10 percent every year. Today, due to control efforts, the population stands at around 8,100.

Despite their beauty, mute swans have had serious repercussions on the Great Lakes ecosystem. The MDNR considers them to be among the world's most aggressive bird species. Males average about 25 pounds, making them extremely dangerous to humans and native wildlife.

MSU sea lamprey research in Hammond Bay, Michigan.

They have a history of attacking people, who stray too close to their nests, as well as pushing native waterfowl such as ducks and Canada geese out of their customary nesting and feeding sites. They pose a particular challenge to common loons and trumpeter swans, both of which are threatened species.

"INVASIVE SPECIES AREN'T SUPPOSED TO BE HERE, AND USUALLY END UP HERE BECAUSE OF HUMAN ACTIVITY."

Scott Winterstein, MSU AgBioResearch wildlife ecologist, is in the midst of a multi-year project, funded by a $300,000 grant from the MDNR Wildlife Division and additional funding and logistical support from the U.S. Department of Agriculture Animal and Plant Health Inspection Service. He is studying mute swan population dynamics in Michigan and has determined an efficient, socially acceptable strategy for controlling their population.

"Mute swans present an issue that impacts the ecology of the state, as well as a number of human activities like boating, bird-watching, hunting and fishing that depend on that ecology," Winterstein, professor and chairperson of the MSU Department of Fisheries and Wildlife, said. "In order to properly address it, we need to get a better idea of what the population looks like and how different management tactics might impact it."

To return the birds to a manageable level and reduce their potential to negatively impact the ecosystem, the MDNR estimated the population had to be reduced to at least 2,000 animals – about where it was in the 1990s.

Together, Winterstein and MDNR avian research specialist David Luukkonen developed a plan to update the mute swan population model. The old model, largely based on the birds in their native range, did not reflect the realities of their existence in the Great Lakes region.

"Getting a better understanding of mute swan population dynamics here, where they don't have the same constraints as in their native habitat, will help us develop a more accurate model and better control strategies," Luukkonen said. "It will also help us avoid unforeseen consequences of those strategies, like if we reduce the number of birds, but the remainder actually reproduce at a higher rate."

To study the birds in the wild, Winterstein's team fitted approximately 71 mute swans with solar-powered GPS tracking collars. Every day, the collars automatically transmit their locations through the cellular phone network, giving data on movement without requiring the use of conventional, manually operated radio telemetry technology. It can also give life expectancy data at various stages of the bird's life.

The team is also monitoring mute swan nests at six sites around the state. Using small programmable temperature sensors planted in the nests, the team remotely records when swans are incubating eggs. This allows them to estimate hatch dates and understand the birds' reproductive rates.

Randy Knapik, a Ph.D. candidate in the MSU Department of Fisheries and Wildlife, has been collecting data from the nests and collars for the last two years with one more year to go.

"We're looking at every stage of the mute swan life cycle, from egg to juvenile to adult," Knapik said. "We're gathering all the information we can so that we can build an accurate model and make the best management recommendations we can."

With an accurate population model, the team will be able to determine when and how to apply management strategies – from culling adult birds before they reproduce to oiling nests, rendering the eggs unviable – are effective. Management of mute swans will allow more space for species like the trumpeter swan to gain a bigger foothold in their native range.

"Invasive species aren't supposed to be here, and usually end up here because of human activity," Knapik said. "I think we have an obligation to use science to fix that problem." ▯

MSU fisheries and wildlife students conduct sea lamprey research near Hammond Bay, Michigan.

Technicians implant tracking devices into sea lamprey.

MSU sea lamprey research in Hammond Bay, Michigan.

Mute swans were brought from Europe to the United States for their aesthetic beauty, but the large, aggressive birds have caused significant disruptions to native waterfowl and their habitat.

Above:
MSU Professor Tom Fernandez (middle) with graduate student Damon Abdi and MSU Professor Emeritus Ron Perry.

Below,
NC-1186 team won the 2017 Experiment Station Section Excellence in Multistate Research Award

BY HOLLY WHETSTONE, EDITOR

Reducing water use in ornamental plant production earns top distinction

When Tom Fernandez was a graduate student pursuing his doctoral degree at Michigan State University (MSU), his academic adviser Ron Perry was working on a large multistate research project (NC-140) focused on improving tree fruit production and sustainability through changes in rootstocks.

Perry would bring Fernandez along with him to informational meetings all over the U.S. Those researcher-grower gatherings gave Fernandez an opportunity to meet some of the biggest names in horticulture, providing him a definite leg up.

"By the time I finished my Ph.D., I knew a lot of people working in fruit production across the country," Fernandez said. "It was extremely good for my professional development. Most of my peers didn't have a mechanism like that to meet so many people in academia or the industry."

Today, some 22 years later, Fernandez – now an MSU professor of horticulture – is spearheading his own multistate research project, NC-1186, through the same group – the Experiment Station Committee on Organization and Policy (ESCOP).

Fernandez is focused on improving water quality and water management in ornamental crop production – an industry nearly 100 percent reliant on irrigation. He's experiencing firsthand the benefits of this type of cross-country research collaboration from a development perspective.

"It's been very good for everybody's growth, not just junior faculty starting out – but mine as well," he said. "Since our meetings vary across the country in large ornamental plant production states, we've taken advantage of the group's expertise to hold grower seminars in conjunction with our project meetings. We've done that in Michigan, North Carolina and next year, in northern California. We also get to visit the best growers in these regions and learn from their successes and develop research to help solve their problems."

The overarching intent is to provide a mechanism for scientists interested in water quality and water management issues to team up, work together and specifically create research projects around the main topic area. Since launching in 2011, the group consists of 31 members from 22 institutions and has garnered over $21.5 million in grants.

The project has been so successful that it was named the 2017 winner of the Experiment Station Section Excellence in Multistate Research Award. Coincidentally, that honor comes just two years after Perry earned the same ESCOP award for the rootstock research he introduced to Fernandez at the start of his career. Perry served 20 years as a technical representative in NC-140 for Michigan and since 2012, as the administrative adviser for the North Central Research Association. Both projects have been extremely impactful on each of the respective industries – fruit production and ornamental plants.

"I think these two elite awards speak to MSU's ability to really and truly cross-collaborate, not only within our university but with other academic institutions as well," said Doug Buhler, director of MSU's experiment stations now called MSU AgBioResearch. "This doesn't happen everywhere and we're proud to see our researchers paving the way as leaders of such impactful multidisciplinary work."

Perry said Fernandez was one of his brightest, most focused and resourceful graduate students. Fernandez administered Perry's MSU Fruit Schools, and he joined him at the NC-140 annual

meetings and collaborated with one of the regional project cooperators as a part of explaining the essence of rootstock differences when it came to water uptake physiological stress.

The duo also worked with Dave Ferree from Ohio State University on a similar trial, attempting to quantify root mass distribution in two locations to associate with rootstock genetics as affected by soil characteristic differences. He published the results for this work and other research related to his Ph.D.

"Tom, in essence, cut his teeth in learning about the value of multistate research projects as he took advantage of the organizational set up even for his Ph.D. research project in 1991," said Perry.

GETTING THE PROJECT STARTED

The concept for the multistate water management project was Fernandez's. After pitching it to Buhler and receiving his support, Fernandez headed to see John Lea-Cox at the University of Maryland. Lea-Cox was onboard and suddenly Fernandez had the sponsorship of two experiment stations in different states – a requirement of ESCOP projects. Another is to address an issue that one station is not capable of doing on its own.

Water conservation and water quality are high national priorities within agriculture, particularly in the ornamental plant industry where nearly all of greenhouses and about 75 percent of nurseries are dependent on irrigation.

Fernandez contacted people across the country working on water management issues in horticulture and asked them to join the project. Various teams are addressing numerous topics, including:

- Strategies for managing anticipated decreasing availability and quality of water for irrigation use in the green industries.
- Investigation of water conservation methods and improved nutrient management practices to reduce the amount of water used and reduce or remediate production impacts on runoff water quality.
- Safe reuse of water in production or return of water to the surrounding water systems with respect to agrichemicals, abiotic and biotic factors, substrate and nutrient management, and environmental, economic and social issues.
- Urban environmental situations that can degrade water resources and development of appropriate management strategies to mitigate them.

Fernandez works primarily with nurseries – outdoor operations with limited protection from the elements. Nurseries typically grow larger plants than greenhouses do and use more water.

CONSUMERS HAVE A SLIGHTLY NEGATIVE PERCEPTION OF RECYCLED WATER WHEN USED IN PLANT PRODUCTION

While water use varies from operation to operation, Fernandez said a rough industry estimate from the 1990s is 13,500–20,250 gallons per acre per day for container production. And, in general, the reuse of water is typically more common west of the Mississippi River.

"Recycled water is more often used in the western states because they have issues on water quantity, but it's becoming more common in the eastern U.S. because there is more competition for water," he said. "It used to be fairly easy to irrigate – you'd either put in a well or tap a river. Now resources are dwindling and the population is growing. Populations and nurseries are competing because they're in geographic proximity, and in that competition – people will always win."

Many nurseries, however, are starting to incorporate recycled water into their production systems. A process that isn't without its risks.

This is where Fernandez comes in. He and his team are looking at the implications, if any, of incorporating inferior water sources, including recycled water, into nursery operations. Specifically, they are looking at:

- The amount of recycled nutrients and their impact on plant growth.
- Phytotoxic pesticides and whether they're being recycled and cross-contaminating crops.
- Nutrients and pesticides in released water.

One of their early successes was getting the United States Department of Agriculture Specialty Crop Research Initiative (USDA SCRI) grant "Clean WateR3 – Reduce, Remediate and Recycle," which is led by Clemson University. They are examining ways to reduce the amount of water used in the first place thereby reducing runoff and the amounts of contaminants in the runoff. He is also looking at ways to reduce the amounts of phytotoxic compounds so that when it's applied it doesn't have a negative outcome on the plant or the planet in the event it's not recycled.

Bert Cregg, who like Fernandez is also in the Department of Horticulture, is capturing the runoff water and reapplying it to the crops to see if there are adverse outcomes.

The Clean WateR3 group has 86 members. Both NC-1186 and WateR3 have been incorporating grower meetings into their annual conferences and look forward to informing growers in northern California next year. Other team members have developed grower tools for smart phones, a wireless irrigation control system and methods to reduce pathogen impacts in irrigation reservoirs.

SWITCHING CAREER GEARS

Fernandez has three degrees, all in horticulture. He started his career in fruit production but early on transitioned into ornamental plants.

His grandparents owned an ornamental greenhouse in Florida where he worked while growing up. They started it in the mid '70s after his grandmother's green thumb evolved into a full-fledged business concept.

"Like a lot of people that got into the industry back in that era, they really liked growing plants," he said. "My grandmother grew orchids as a hobby. She had a rather large greenhouse for a homeowner, but she decided she wanted to do that as a business. They bought about 5 acres and started a small operation, probably 10,000–15,000 square feet before they retired."

With master's and doctoral degrees, both in plant physiology, Fernandez's first faculty position was working with nursery crops. With the dozens of different species grown on even a small nursery, he decided he needed to expand his expertise beyond working with specific crops.

"I shifted from looking at crops to looking at systems and to me, the most important dynamic system was the water system," Fernandez explained. "We started looking at how to remediate pesticides in runoff water. I came at it trying to use ornamental plants in production as remediation plants."

Others were looking at modified wetlands and constructed wetlands to remediate pesticides but Fernandez had a desire to keep land in production and not shift it into nonproduction.

At the time, however, there was not a lot of funding available for ornamental production. Analyzing pesticides was extremely costly so they couldn't do a lot.

"Project GREEEN (Generating Research and Extension to meet Economic and Environmental Needs) and the Horticulture Research Institute (HRI) have been instrumental in keeping us moving forward to be competitive for the SCRI program," said Fernandez.

With GREEEN and HRI they ended up looking at the effects of various levels of pesticides on plants and what they could tolerate based on what was expected to occur in runoff.

"We also looked at ways to reduce runoff and nutrients in runoff by improving irrigation management.

"Fortunately, SCRI grants came along and we got the WateR3 grant, and we can afford to analyze pesticides," he said. "We've gone from just looking at what

plants can tolerate in terms of pesticides to how we can reduce and remediate the amount of pesticides in the runoff water."

REDUCE. REMEDIATE. RECYCLE

Recently Fernandez, along with NC-1186 members Cregg and Bridget Behe, also in the Department of Horticulture, have shifted away from using plants to remediate pesticides in favor of two-stage bioreactors – using woodchips, a common bioreactor method, as the first stage. When water passes through, microorganisms in the woodchips denitrify nitrates and remediate pesticides.

The Environmental Protection Agency limits the amounts of nitrates that can be consumed in drinking water. Nitrates also contribute to algal blooms and other toxic effects that occur in waterways.

The second stage uses calcined shale, a shale that has been heat-treated until it expands, almost like popcorn. The calcined shale is expected to adsorb phosphorous, which also contributes to the algal blooms in waterways, and should also help in the remediation of pesticides from the water.

Fernandez is looking at irrigation practices, with the goals of reducing the amount of water and reducing the amount of runoff. Nurseries typically use overhead irrigation for smaller pots, but the team is looking at individual pot irrigators, such as spray stakes or drippers, as an alternative. Since all of the irrigation is applied only to the pot, pesticides and fertilizers that land on the groundcover won't be transported by irrigation water. Only rain events will transport them into the runoff stream. In the interim between rainfall, several processes occur that degrade or reduce the movement of pesticides and nutrients.

They plan to pass the runoff water through the bioreactors to further reduce the nutrients and pesticides. Cregg will compare the growth and physiological responses of the plants irrigated with unremediated water, remediated water and those irrigated by typical sources.

Behe will gauge how consumers respond to using recycled water labels in the ornamental plant industry. So far, she has discovered that consumers don't really understand what it means.

"She's found that consumers have a slightly negative perception of recycled water when used in plant production," Fernandez said. "We see this as an opportunity for us to educate consumers."

Fernandez views this entire project as an ongoing learning experience and that the multistate aspect has really helped bolster its impact now and into the future. ▯

BY JAMES DAU, STAFF WRITER

A whole new world:

Opening international blueberry markets through pest management research

IN 1916, THE DAUGHTER OF A NEW JERSEY CRANBERRY GROWER AND A U.S. DEPARTMENT OF AGRICULTURE (USDA) BOTANIST HARVESTED THE FIRST COMMERCIAL CROP OF HIGHBUSH BLUEBERRIES. PRIOR TO THIS, BLUEBERRIES WERE CONSIDERED IMPOSSIBLE TO DOMESTICATE AND IMPRACTICAL FOR AGRICULTURAL PRODUCTION.

Today, just over a century after that first crop made it from the farm to the dinner table, over 1.2 billion pounds of blueberries are produced worldwide every year, with more than half originating in the United States. Their future is bright with the U.S. Highbush Blueberry Council (USHBC) estimating that North American blueberry production will increase by 25 percent by 2019.

As a major producer of blueberries in the nation, Michigan has opportunities to expand businesses through overseas export markets. Tapping into those is not as simple as boxing up blueberries and loading them onto a ship bound for France or Hong Kong, however. Several obstacles stand between Michigan growers and the lucrative markets of Europe and Asia, chief among them a fly less than a third of an inch long.

The blueberry maggot fly has been a major pest of blueberry growers since the birth of the industry. Female flies lay 25-100 eggs inside individual blueberries, where the larvae hatch and devour the fruit as they grow over approximately a three-week period. Larvae drop into the soil, pupate and wait through the winter, emerging as adult flies in the next season.

AN OBSTACLE TO TRADE

First reported in 1914 and native to the major blueberry-growing regions of eastern North America, the blueberry maggot fly is common throughout Michigan, but a combination of natural parasite species and integrated pest management practices allow growers to effectively control it and prevent the damage it can cause.

It is not present in most overseas markets, however, nor are there any natural defenses against it. This has made it a quarantine pest, with some trading partners not accepting blueberries from Michigan because of the potential risk it poses. This is a problem Michigan State University (MSU) AgBioResearch entomologist Rufus Isaacs is aiming to solve.

"Growers in the United States have a lot of ways of effectively managing the blueberry maggot fly," said Isaacs, professor in the MSU Department of Entomology and MSU Extension specialist. "But trading partners such as China and Australia do not have this pest, nor a strategy developed to control it. They are highly concerned about preventing its entry, so we also need strategies that can guarantee any stray blueberry maggot that survives to harvest is eliminated before the fruit are shipped."

To this end, the USHBC approached Isaacs to assemble a team of researchers to develop strategies to eliminate blueberry maggot from the fruit after harvest to meet the import standards of potential trade partners. With funding from the USDA Trade Assistance for Specialty Crops program and in collaboration with scientists from the USDA Agricultural Research Service in California, they proposed to test three different post-harvest techniques to purge blueberries of the blueberry maggot and ensure the pest does not spread beyond its native range.

The team elected to test a variety of methods to provide growers with multiple options, as well as to make sure that both small and large growers had methods they could feasibly implement into their operations.

Philip Fanning, postdoctoral researcher in Isaacs's lab, manages much of the day-to-day operations of the project team.

"At MSU, we're working on helping blueberry growers take advantage of the increasing global demand for their crop," Fanning said. "That means looking at practices that small growers can implement now, as well as investigating new technological approaches for growers with the resources to invest in them."

Testing these methods would be impossible without the cooperation of Michigan's blueberry growers. Growers have provided large volumes of their clean fruit while others have allowed access to abandoned fields that provide a source of infested fruit, which Fanning collects and delivers to the team as valuable test subjects.

"This is very much an industry-led project," Fanning said. "They recognize the value of eliminating this pest and opening export markets, and are working with us to help improve the marketing of blueberries."

Top Left and above
A blueberry maggot fly perches atop a ripe blueberry. Female flies lay as many as 100 eggs inside a single blueberry, where they hatch and consume the fruit as they develop.

Top Right
While native to the eastern United States and Canada, many overseas trading partners do not have blueberry maggots, nor the means to combat them. In order to ensure the pest does not spread abroad, Isaac's team is exploring multiple strategies to eliminate them from Michigan blueberries after harvest.

A THREE-PRONGED STRATEGY

One method already in common use in fruit agriculture, both for pest control and for extending the life of fruit, is cold storage. In this, harvested fruit is placed in specialized low-temperature chambers for a period of about two to three weeks. During this time, the activity of pests is slowed dramatically, reducing development, consumption and eventually leading to their deaths. In the case of some pests, such as the Queensland fruit fly, this method alone is enough to eliminate them entirely.

"Cold storage has a lot of potential for helping us eliminate blueberry maggots, and it has the added benefit of being relatively easy for growers to implement regardless of the scale of their operation," Fanning said. "Our current tests are already showing success at the small, experimental level. We have to see what that looks like when we take it to a commercial scale, but so far it's promising."

The second technique the team is exploring attempts to use the laws of physics to gain an advantage over the pests. By storing blueberries in hypobaric chambers, which can reduce the pressure inside to about 2 percent of typical air pressure, the team hopes to increase the efficacy of fumigant gases capable of killing any unwanted infestation.

Under reduced pressure conditions, introduced gases expand faster and penetrate deeper into stored fruit by the simple virtue of there being significantly fewer other molecules in their way.

Randy Beaudry, professor in the MSU Department of Horticulture, has been studying low-pressure storage technology for the last two years, working with a diverse group of crops including spinach, strawberries and roses. His team demonstrated it was not a viable solution to the needs of those growers, but sees potential for it in the case of blueberries.

"These low-pressure systems have been in use in horticulture for some time, as a way of extending the storage life of plants, so this equipment already exists for growers at a commercial scale," Beaudry explained. "What we're looking at is seeing if we can adapt it to help us eliminate pests, to find new uses for old technology."

For the last six months, Beaudry's team has been testing different concentrations of sulfur dioxide. Team members plan to test one gas per year for the duration of the project. While each of the compounds Beaudry is testing degrades rapidly, leaving little risk of health effects, the team will also evaluate their safety for human consumption.

While Beaudry's team has not yet brought blueberry maggot infestations down to an acceptable level for international trade, he remains cautiously optimistic about the technology's potential.

"GROWERS, PROCESSORS AND MARKETERS ARE VERY INTERESTED IN THE PROSPECT OF EXPANDING THEIR MARKETS BY OBTAINING NEW TOOLS TO FIGHT COMMON PESTS LIKE BLUEBERRY MAGGOT," ISAACS SAID. **"THIS PROJECT IS A DIRECT RESPONSE TO AN INDUSTRY NEED, AND THAT'S WHAT WE TRY TO DO HERE AT MSU."**

"So far, we've done preliminary tests and killed a lot of insects," Beaudry said. "You have to kill 99.999 percent of them to make the fruit safe for export, and we're not there yet. We've been testing very heavily infested fruit, and it may be that we see more positive results on fruit with more natural pest levels, the kind you'd see in the field."

The third and final technique the team is exploring, under the purview of MSU food safety engineer Sanghyup Jeong, uses irradiation technology to kill blueberry maggots. Irradiation is an increasingly common practice for removing insect pests, disease-causing bacteria and other microorganisms from fruit, vegetables and meats without having an impact on their nutritional value.

Jeong, assistant professor in the MSU Department of Biosystems and Agricultural Engineering, is partnering with a Michigan-based company developing irradiation technology for food safety systems. Through this partner, Jeong has access to a pilot-scale facility capable of treating blueberry batches at near-commercial levels.

Lab technician Olivia Horton and MSU Department of Entomology Professor Rufus Isaacs examine blueberry clusters for pests in a pollination experiment.

"We're using X-ray radiation, which is less energy-intensive than other forms of the technology and, therefore, more cost effective for growers," Jeong said. "It makes it available to more than just large-scale growers; it allows us to help more people."

In previous research, Jeong and a team of food safety researchers demonstrated the efficacy of irradiation technology against critical bacterial pathogens such as *E. coli* and *Salmonella.* Now, he is trying to scale that up to more complex organisms, including the blueberry maggot.

LOOKING AHEAD

While the blueberry maggot fly project is only in the first of its three-year run, the team is already seeing progress.

"We're definitely seeing we can significantly reduce the blueberry maggot through some of these techniques," Fanning said. "From this year's work so far, it looks like we can have a program similar to the ones we use in other exported fruit like grapes. Elimination of the maggot should be possible by the end of this project."

Going into the next two years, the team will be taking their early experiments and scaling them up to the commercial level, to ensure that their findings remain practical for growers in the field. Research priorities will also focus on ensuring these techniques will maintain fruit quality, in order to ensure consumers continue to enjoy the fresh blueberries that are quickly becoming a staple in supermarkets year-round.

Success will mean providing the more than 600 Michigan blueberry growers with new opportunities to grow their businesses and send Michigan blueberries around the globe.

"Growers, processors and marketers are very interested in the prospect of expanding their markets by obtaining new tools to fight common pests like blueberry maggot," Isaacs said. "This project is a direct response to an industry need, and that's what we try to do here at MSU." ▯

OUR TABLE

makes its community debut in Michigan

BY HOLLY WHETSTONE, EDITOR

(From left) Our Table moderator Sheril Kirshenbaum, and panelists Lorraine Weatherspoon, Rich Pirog, Joan Nelson, Joe Garcia and Dilli Chapagai.

Photos by Derrick Turner, MSU Communications and Brand Strategy

Food access was the topic of lively conversation as Michigan State University (MSU) hosted its first "Our Table" event on Nov. 16, the Thursday before Thanksgiving. More than 100 guests from the local community and MSU attended the event held at Cristo Rey Community Center, 1717 N. High St. in Lansing. Attendees were encouraged to donate to their local food pantry or to Cristo Rey.

Joseph Garcia, executive director of Cristo Rey Community Center, said access to healthy, affordable food is something most take for granted, but it's a real concern for many.

"Food is a big part of what we do here (at Cristo Rey)," said Garcia. "We need to make connections between better eating and improved health to lessen the likelihood of people getting sick. I hope this event will be the start of MSU and Cristo Rey Community Center working more closely together to make important impacts like these."

In addition to Garcia, "Our Table" panelists were:

- Dilli Chapagai, Greater Lansing Food Bank
- Joan Nelson, Allen Neighborhood Center
- Rich Pirog, MSU Center for Regional Food Systems
- Lorraine Weatherspoon, MSU Department of Food Science and Human Nutrition

They sat at a wooden table made from fallen MSU campus trees crafted for this initiative. It was created by artist Nathan Shaver who works with MSU Shadows, part of the Department of Forestry.

Sheril Kirshenbaum, a science communicator and author of "Unscientific America: How Scientific Illiteracy Threatens Our Future," moderated the conversation.

"'Our Table' aims to inspire people to cast aside their phones and engage in meaningful conversations not only in communities, but in homes and around dinner tables," Kirshenbaum said.

This was the first in a series of "Our Table" discussions in which MSU brings together food experts, agricultural producers, health professionals and community members to listen to each other and foster dialogue. It is part of Food@MSU, a new campus-wide initiative led by the colleges of Agriculture and Natural Resources (CANR), Arts and Letters, and Communication Arts and Sciences that aims to help consumers make more informed decisions about food, and its impacts on health and the planet.

Learn more at food.msu.edu.

“THE ISSUES WE DEAL WITH IN OUR FIELDS, LABORATORIES AND CLASSROOMS – ON CAMPUS, ACROSS THE STATE AND AROUND THE GLOBE – HAVE NEVER BEEN SO VITALLY IMPORTANT TO SO MANY PEOPLE. BUT IT’S ALSO IMPORTANT THAT WE PAY ATTENTION TO THE NEEDS OF OUR NEIGHBORS, AND THIS IS ANOTHER WAY WE WANT TO DO THAT. I HOPE YOU HAVE AN INFORMATIVE AND REWARDING CONVERSATION TONIGHT AND THAT YOU CONSIDER MSU A KNOWLEDGE PARTNER AS, TOGETHER, WE FIND NEW AND BETTER WAYS TO MAKE NUTRITIOUS FOOD AVAILABLE TO ALL.”

– Lou Anna K. Simon
President, MSU

THE MICHIGAN TREE FRUIT COMMISSION:

Partnering with MSU to improve research, outreach for industry

BY CAMERON RUDOLPH, STAFF WRITER

TREE FRUITS, LIKE MANY OTHER SPECIALTY CROPS, DO NOT TYPICALLY GENERATE MUCH PRIVATE-SECTOR SUPPORT FOR RESEARCH AND OUTREACH. BUT THAT DOESN'T MEAN THEY'RE NOT BIG BUSINESS.

In Michigan alone, apples are the largest and most lucrative fruit crop, surpassing even cherries, which bring in nearly $100 million annually. Other tree fruits, particularly peaches and plums, have smaller footprints around the Great Lakes State, but certainly contribute to Michigan's great diversity in agriculture.

These fruit industries, all heavily reliant on public and industry support, faced critical needs several years ago when Michigan faced economic challenges. Collectively, they banded together along with Michigan State University (MSU) – one of its principal partners, to find a solution to keep the tree fruit industry competitive and sustainable.

MEETING THE RESEARCH INFRASTRUCTURE NEEDS

Years of declining funding had manifested itself in numerous ways at MSU, especially in terms of research infrastructure. MSU has four off-campus facilities across the state that host tree fruit research: the Clarksville Research Center in Clarksville, the Northwest Michigan Horticulture Research Center in Traverse City, the Southwest Michigan Research and Extension Center in Benton Harbor, and the Trevor Nichols Research Center in Fennville.

A 2013 committee assembled by MSU AgBioResearch conducted a study that showed a correlation between the substantial decrease in funding for the MSU research centers and major needs for both infrastructure and staff.

"The study really opened our eyes to the fact that we had to find a new way of doing things if we wanted to maintain a strong industry," said Jim Nugent, a cherry grower and owner of Sunblossom Orchards in Leelanau County. "That means investing as an industry in research and extension."

Another member of the committee — Phil Korson, president of the Cherry Marketing Institute — saw an opportunity to bring together tree fruit commodities for a common cause.

"Because the four research centers already cover the four primary tree fruit crops — apples, cherries, peaches and plums — there was an obvious connection that brought the groups together," Korson said. "The timing was

MSU AgBioResearch Director Doug Buhler works with the Michigan Tree Fruit Commission to improve MSU's research and outreach capabilities.

right, in that the State of Michigan has been very supportive of agriculture."

Several groups, including the Michigan Apple Committee, the Cherry Marketing Institute, the Michigan State Horticultural Society and the Michigan Agricultural Cooperative Marketing Association, recommended that growers band together to form a larger tree fruit organization.

After gaining the support of growers, the Michigan Tree Fruit Commission (MTFC) was born.

PAVING THE WAY FOR A BRIGHTER FUTURE

The MTFC was established in 2014 under Public Act 232, the same legislation that permits other commodity organizations to form and solicit grower funding for marketing activities. The commission consists of nine growers and has a five-year term before another vote by growers is required to continue operations.

Grower dollars have been matched by the State of Michigan, and thus far equate to $2.9 million. Korson said a unique benefit of the MTFC is that partners have agreed to perform administrative functions at no cost to the commission. Therefore, no formal support staff is needed.

"Having the administrative portion of the commission covered by the commodity organizations and MSU is of enormous benefit," Korson said. "It means that all of the money goes directly to the program for things like infrastructure, equipment and professional development."

Nugent is chair of the MTFC, and the commodity organizations handle many administrative tasks. MSU has provided services from financial management to communications and on-site research center oversight for new infrastructure and equipment. In addition to funds for meeting core MTFC objectives, growers and organizations have donated time and resources.

Phil Korson, president of the Cherry Marketing Institute.

"We've had a great, collaborative experience so far and not just in terms of big-picture needs," Nugent said. "We have requirements outside of research projects — maintenance pesticides and everyday equipment. Items like that have been contributed, and that exemplifies the tremendous enthusiasm the commission has generated."

Faculty and staff positions at MSU have been filled with assistance from the MTFC, in the form of helping with funding for needed equipment and initial support. Two new faculty members in the Department of Horticulture, Todd Einhorn and Courtney Hollender, were hired in 2016. David Jones, an MSU Extension educator in western Michigan, and Marisol Quintanilla, a nematologist in the Department of Entomology, have joined the university as well.

"We're grateful to the commission's partners for entrusting MSU with the responsibility of delivering research and extension information to growers," said Doug Buhler, the director of MSU AgBioResearch.

"Grower contributions to our research facilities underscore the important relationship that has developed over time. In just a few years, the MTFC has strengthened that bond by positioning us to meet long-term grower needs."

At the four research centers, tractors, sprayers, orchard platforms, deer fencing, irrigation controllers and pruning equipment have been purchased. One significant investment is a small-scale apple grading line for use by researchers and MSU Extension educators, which also received support from the Michigan State Horticultural Society, the Michigan Apple Committee and MSU.

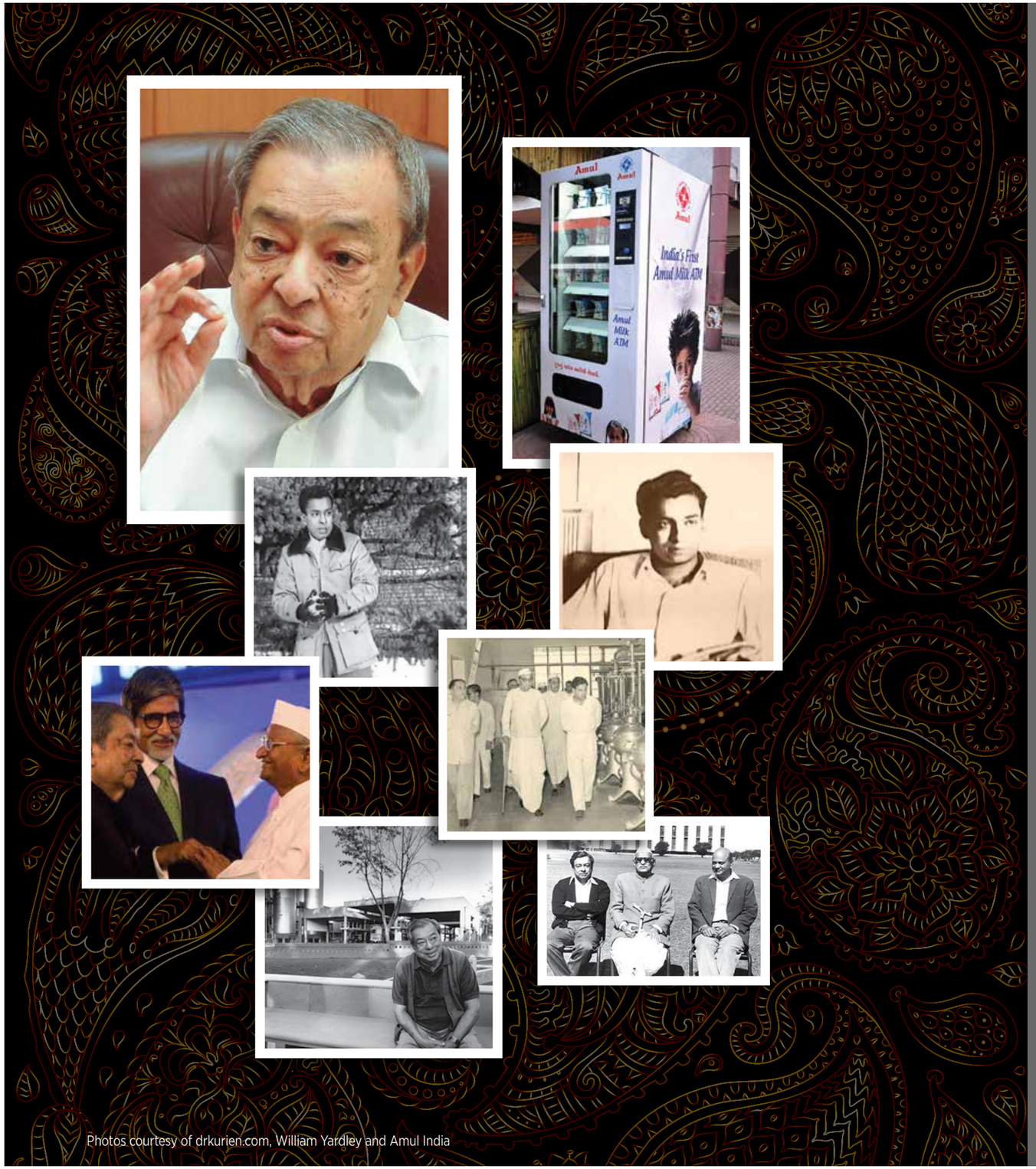
The grading line is able to quickly rate apples using high-powered imaging software. The data collected informs reviewers about color, weight, external blemish detection and internal damage.

As both a grower and chair of the MTFC, Nugent sees research and outreach as a way to enhance the reputation of Michigan's tree fruit industry – both throughout the state and across the country.

"Specialty crops like tree fruit receive relatively little private sector support in terms of research, so we rely on our growers and on public research at places like MSU," Nugent said. "Because Michigan is a dominant player in the cherry industry, for example, the entire country really looks to MSU for answers to a lot of questions. We are a leading provider of that knowledge, and that's true of other tree fruits as well."

Korson added: "We have set the stage for the next generation of fruit growers to have a robust research partnership with MSU to address the challenges that will come. I am very proud of what we have been able to do. It will pay long-term dividends for the fruit industry." ▯

- **Michigan has more than 800 family-operated apple farms.**
- **In 2016, Michigan produced 28 million bushels of apples** valued at $295 million.
- **Michigan ranks third in the U.S. in apple production** behind only Washington and New York.
- **Roughly three-quarters of the tart cherries grown across the country are from Michigan**, in addition to about 20 percent of sweet cherries. The Lower Peninsula's northwest counties constitute the bulk of the growing region.



Photos courtesy of drkurien.com, William Yardley and Amul India

By Anna Nichols
CONTRIBUTING WRITER

SEEKING EQUITY FOR DAIRY FARMERS IN INDIA WAS LIFELONG LEGACY

There are few, if any, Michigan State University alumni who have influenced more lives than Verghese Kurien. Hailed as the "Milkman of India," Kurien is credited with spearheading a movement that revolutionized India from a dairy-deficient country to the world's largest milk producer.

THIS WAS ACHIEVED IN LARGE PART THROUGH AMUL – A DAIRY COOPERATIVE KURIEN HELPED TO FORM WITH HIS PEERS. THE COOPERATIVE EMPOWERED THOUSANDS OF DAIRY PRODUCERS TO GAIN BUSINESS STABILITY AND THRIVE. TODAY AMUL HAS TRANSFORMED INTO INDIA'S LARGEST FOOD BRAND. IT IS CREDITED WITH THE INVENTION OF MILK POWDER FROM THE ABUNDANT BUFFALO MILK INSTEAD OF FROM COW MILK, WHICH IS IN SHORT SUPPLY IN INDIA.

Ironically, in winter 1946, when Kurien first arrived at Michigan State University (MSU), he had little interest in dairy. He had been chosen for a government scholarship to pursue an education in dairy engineering only after answering a question about pasteurization. He responded by saying that it had something do with milk. That was all it took and he found himself at MSU.

Kurien went on to flourish at MSU – debating fellow students on subjects of interest and winning a tennis championship. He earned a master's degree in mechanical engineering, with a minor in nuclear physics, in 1948.

This fall, Satish Udpa, MSU executive vice president for administrative services, opened a memorial talk honoring Kurien – who died in 2012 – with a statement about the success of Amul.

"Today India produces more milk than any other country. It produces more than the U.S. It produces more milk than all of the countries in the European Union," said Udpa. "You cannot go to any store in India and not find Amul products and that is because of the genius of all the people who are involved in this company."

Kurien's daughter Nirmala also spoke at the same memorial. She said her father worked hard for equity and equality. In addition, she said she recalled how he was taken aback by racial slurs and the segregation of the bus system in the U.S.

"When he started working for the cooperatives in Gujarat, he was firm that there would be only one line when milk was collected twice a day," she said. "One line every day for the year whatever your class, creed or sex may be."

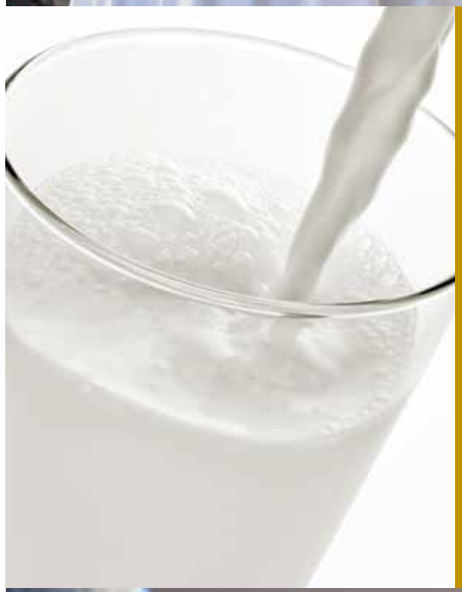
She added that her father saw no reason for anyone to be passed over for success or taken advantage of for the sake of enterprise. That's what inspired him to help farmers in India become more self-sufficient and successful.

R.S. Sodhi, managing director of Amul India, speaks at an MSU event honoring Verghese Kurien earlier this year.

HOW IT ALL BEGAN

In the 1930s, Polson Dairy products had obtained a monopoly over India's dairy industry by working closely with the government to be the only distributer allowed to buy from the Kaira District – the epicenter of milk in India. Producers had little choice but to comply. Consequently, Polson became a successful profitable brand, yet farmers saw little in the way of prosperity in return.

Pushed into action, farmers sought counsel about how to improve their economic and social positions from political leader and future deputy prime minister of India Vallabhai Patel. Patel was adamant about the need to cut out the intermediary in farming and organize into cooperatives. He was convinced that when the producers led every aspect of production and distribution, they'd get a fair profit in return. They followed his advice and formed the Kaira District Cooperative Milk Producers Union.



Above:
R.S. Sodhi, managing director of Amul India, gives the keynote address during the memorial event.

Middle right:
Verghese Kurien's daughter Nirmala also spoke saying her father worked hard for equity and equality.

Below, right:
Satish Udpa, MSU executive vice president for administrative services, opened the memorial.

Below:left
Guests at the memorial.

Middle: left
Verghese Kurien was known as the "Milkman of India."

Kurien arrived back in India in 1949 to serve out his bond to the government at an outdated experimental creamery at Anand. Growing increasingly dissatisfied in his small town, he tried everything to get out of his government-mandated job. He managed to get permission to leave but agreed to stay three months to help install a new pasteurizer and to get it running. He ended up staying for the remainder of his life – 63 years.

The entire time, Kurien fiercely campaigned for a better quality of life for dairy producers in his homeland. Seeing their struggles against a system that could not function without them was unacceptable to Kurien.

"WHO WOULD HAVE IMAGINED THAT A COOPERATIVE FORMED BY SMALL AND MARGINALIZED FARMER GROUPS FROM TWO TINY VILLAGES LOCATED IN THE HEART OF GUJARAT 70 YEARS AGO WOULD ONE DAY TRANSFORM INTO INDIA'S LARGEST FOOD OPERATION?"

– R.S. SODHI, MANAGING DIRECTOR OF AMUL INDIA

It was at the World Food Program in 1968 that Kurien spoke to members of European countries who had a surplus in milk production. He told them about his idea to make India a self-sufficient country in dairy. His presentation convinced the countries to donate milk to India. It was a huge step in Kurien's master plan. With the donations, he helped cities across India gain footing in the dairy industry and increase production. He knew if the dairy industry of India was to thrive, farmers would also have to become the salespeople distributors to take back some of their power.

Kurien financed his plan from the resale of the milk and replicated the work all over India, forming more cooperatives. This became known as Operation Flood.

R.S. Sodhi, managing director of Amul India, who spoke at the same MSU event, said Kurien reached out to farmers that lacked even the opportunity to step inside a primary school. By opening the gates and allowing them to navigate their own industry, farmers were empowered to sell their products.

"Who would have imagined that a cooperative formed by small and marginalized farmer groups from two tiny villages located in the heart of Gujarat 70 years ago would one day transform into India's largest food operation?" said Sodhi of the organization that would later be called Amul. "No one could have predicted that an enterprise that started by just collecting two 50 liters of milk per day in 1946 (would) one day become 22 million liters per day."

In 1989, Kurien was awarded the World Food Prize for revolutionizing the organization of India's dairy industry by founding the National Dairy Development Board, which then pioneered Operation Flood. In his acceptance speech, he stated that it was the courage of over 6 million dairy farmers who organized into 60,000 cooperatives at the time that gave him the strength to challenge an industry.

"Operation Flood, the program that has transformed India's dairy industry, is not a story of the triumph of science and technology; there have been no miracles," said Kurien. "How then was our White Revolution made possible? I would submit that one very important reason is that we have created structures that give our farmers control over the resources they create." ▯

Rebecca Grumet: A lifelong love for research & discovery

Rebecca Grumet, professor in the Michigan State University Department of Horticulture, works on the genetics, genomics and biotechnology involved with a group of food crops called cucurbits (cucumbers, melons, watermelons, squashes, pumpkins). Much of her work addresses the destructive disease *Phytophthora capsici*.

The disease is hard to detect at first and poses a threat to Michigan's thriving pickle industry.

"When we're talking about cucumbers, this disease primarily infects fruit, not the leaves or the vines," she said. "Farmers could look at a field and it could look beautiful, but the fruit that would be underneath the leaves, in contact with the soil could be heavily infected.

"Diseases are one of the primary limiting factors for agricultural production. This is true for many crops, and is certainly the case for cucurbit crops. Farmers can experience tremendous losses, both in outright yield, and in product quality.

"When talking with growers of these crops, diseases are consistently identified as a major production constraint," said Grumet.

In addition to decreased yields, plant diseases cause increased costs for farming, including expenses for pesticides (fungicides) and the time and labor needed to apply pesticides or to implement other disease control practices. Grumet said plant breeding for disease and pest resistance is the most cost effective and environmentally desirable solution to these challenges.

Name: Rebecca Grumet

Title: Professor, Department of Horticulture

Joined MSU: July 1987

Education: B.S., Cornell University, 1978

M.S., Michigan State University, 1980

Ph.D., Michigan State University, 1985

Postdoctoral Fellowship, Duke University, 1985–1987

Hometown: Syracuse, New York

Muse (person who has most influenced and/or inspired me):
My first thought is Norman Borlaug. I grew up in a time when the environmental movement was gaining great momentum and there were concerns about upcoming world food shortages. I wanted to be part of the solution, and then I learned about Norman Borlaug and his amazing contributions to alleviating world hunger. Perhaps he is more of a hero than a muse to me.

On a more proximal level, there are so many people throughout my life who have influenced and inspired me: high school earth science and biology teachers, undergraduate research advisers, graduate school professors and a host of MSU faculty and administrators who have opened new vistas of learning, set examples, offered guidance and provided so many exciting opportunities over the years.

On my bucket list:
The opportunity to travel with my husband! We have both traveled extensively over the years for work. I look forward to a chance to share more of our trips together.

Favorite vacation:
My favorite vacation is any vacation filled with beautiful scenery, opportunity to hike and to be with the people I love. There have been many!

On a Saturday afternoon, you'll likely find me:
Working in the yard or cooking to share with family and friends.

Best part of my job is:
The continual opportunity to learn, grow and work with wonderful people. There are so many opportunities at every turn with the chance to do exciting and meaningful work in the laboratory, classroom, within MSU or with colleagues nationally and internationally.

If I wasn't a researcher I'd be:
Being a researcher was always my dream career (even since high school). I think I could be happy doing other things, but there is nothing else that I ever truly considered.

Something many people don't know about me is:
At age 14, I spent eight weeks in a camp in the Adirondacks without running water or electricity (only an outhouse, wood burning stove). As I've gotten older, I've come to think it had a profound influence on me and my view of what we really "need" in life.

I went into this field of study because:
I love biology, genetics, physiology and the opportunity to connect them to something meaningful. Once I took genetics, a light bulb went off and life made sense to me in a completely new way. ▯

Rebecca Grumet, MSU horticulture professor

By Anna Nichols, CONTRIBUTING WRITER

MICHIGAN STATE UNIVERSITY | AgBioResearch

446 W. Circle Drive
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Michigan State University
East Lansing, MI 48824

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